Saskatchewan
Agriculture

Agriculture Development Fund

2.2-10 (A)

PRELIMINARY EVALUATION OF THE EFFECT OF SEED SIZE AND SEED SOURCE OF KOCHIA ON GERMINATION AND EARLY GROWTH

by

E. Coxworth, A. Mair, E. Swerhone,

and J. Kernan

SRC Publication No. R-814-3-E-88

February, 1988

91-01872/

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
INTRODUCTION	1
OBJECTIVES	1
MATERIALS AND METHODS	2
RESULTS AND DISCUSSIONS	4
Variation in seed size distribution and seed size	4
Extent and rate of germination	5
Effect of seed size on germination and early growth of Saskatchewan kochia	7
CONCLUSIONS	9
REFERENCES	10

ACKNOWLEDGEMENTS

This project was funded by the Canada-Saskatchewan ERDA Agreement, Contract 2.2-10.

INTRODUCTION

Texas kochia seed germinated much more rapidly than native kochia seed in initial studies. Since larger seeds of other crops, eg. oats, often produce stronger, higher yielding, plants than smaller seeds (Tibelius and Klinck, 1986), and can be planted deeper where more moisture may be more readily available, an investigation to also compare seed sizes of kochia was warranted. This study was undertaken to compare seed size and seed source effects on germination rate and extent, and on emergence and early growth of native kochia seed planted at various depths. High scores on all properties would be desirable to ensure good stand establishment of a small seeded annual forage crop like kochia.

OBJECTIVES

To determine the effects of seed size on the germination rate of both Texas and native kochia, and on the emergence and early growth of native kochia planted at various depths.

MATERIALS AND METHODS

Native Saskatchewan kochia (1985 harvest) was obtained from D. Marin of Radville, Saskatchewan, and Texas kochia (1985 harvest) was obtained from A. Nieto of Vega, Texas. The seed was separated by rubbing it through several sizes of Tyler screens with a large rubber stopper. This action tended to remove the seed coats (calyx and most of pericarp) from most of the seeds. Sieving and air blowing removed the chaff. The seed was retained on #16, 18, 20 and 30 mesh screens (Tyler numbers).

Germination tests were conducted at 25°C in glass petri dishes containing one sheet of Whatman #3 filter paper soaked with 4 ml of distilled water. Inside diameter of the Petri dish was 13.8 cm. This size of Petri dish will accept up to 10 ml water on one sheet of #3 Whatman paper without excessive free water.

Texas and native kochia seeds of seed sizes greater than 16, 18, 20 and 30 mesh (Tyler #'s) were compared. Comparisons were made between seeds virtually free of pericarp and seeds retaining significant amounts of pericarp. Seed types were selected visually. Three dishes containing 30 seeds each were tested for each test variable (seed size, seed source, pericarp retained or not) totalling 24 dishes of Texas kochia seeds and 24 dishes of native kochia seeds. The number of seeds germinating at specific times, up to 48 hours, was counted.

A preliminary trial of 20 seeds per dish for pericarp coated and uncoated seeds from both seed sources was conducted to observe the approximate germination rate. This helped to know when to set up the main trial so that the germinating seeds could be counted at convenient times.

For the study of seed size on planting depth, large seed was selected as those seeds which were collected using >16 mesh (≈1.00g/1000 seeds). Small seed was selected using a >20 mesh (≈0.46g/1000 seeds).

The seed depths to be tested were chosen as 3mm, 6mm, 10mm, and 15mm below the soil surface (equivalent to 0.12", 0.24", 0.39", and 0.59").

All tests were done in triplicate. Pot sizes were 95 cm^2. Non sterile sandy loam soil (from Dressler Landscaping, Saskatoon, Saskatchewan) was used. Twenty seeds were planted, evenly spaced in each pot.

The first watering was done, after all the seeds were planted at the various depths, by placing the pots into basins of tap water. The water was allowed to move through the soil in the pots from the bottom up, via capillary action. Afterwards, watering was done very carefully, by hand, on the soils' top surface. All the pots were watered at the same time, about every 2 - 3 days. All pots were placed in the same growth room at about 65 - 67°C. The light period was 12 hours per day, using cool white fluorescent light fixtures supplemented with incandescent light bulbs. The light sources were placed approximately 25 cm above the soil surface.

Seedling emergence, height at several growth intervals, and final fresh weight after 21 days from seeding, were measured.

RESULTS AND DISCUSSIONS

Variation in seed size distribution and seed size

The seed obtained from Texas and Saskatchewan, as cleaned and separated by the combine, appeared to have the calyx and pericarp still attached. The calyx, and a portion of the pericarp, was removed by rubbing the seed on Tyler screens ranging from sizes #10 to 30. After rubbing and removing chaff by air blowing, the seed was again sieved (without rubbing) prior to measuring the amount retained on different sized screens.

The results from single processing of Texas and Saskatchewan seed are shown in Table 1.

Table 1. Size distribution and seed weight of kochia seed, from two sources, after removing calyx and most pericarp.

Tyler Screen size on which seed retained	Percent of cleaned seed		Weight of 1000 seeds (grams)	
	Saskatchewan	Texas	Saskatchewan	Texas
> 16 mesh	5.7	28.4	1.008	0.908
> 18 mesh	26.4	40.6	0.776	0.744
> 20 mesh	49.7	25.3	0.465	0.494
> 30 mesh	18.3	5.8	0.293	0.272

The weight loss of calyx and pericarp, on seed cleaning, was 27% in the case of Saskatchewan seed, and 25% in the case of Texas seed.

There was over a threefold difference in kochia seed size, as separated by Tyler screens of 16-30 mesh. The Texas seed had more of the larger sized seeds than the Saskatchewan seed sample.

Extent and rate of germination

An overall comparison of Texas to native kochia seeds showed that the Texas seeds had a quicker and higher germination rate. In both cases, the pericarp uncoated seeds germinated faster than the seeds still coated with pericarp.

The largest seeds, >16 mesh, germinated first and also gave the highest percent of final germination. Smaller seeds, i.e., >18 and >20 mesh, were slower to germinate, with a lower final percent of germinating seeds. Very small seed (>30 mesh) had the lowest percent of germination. The effect of seed size, source, and the presence of pericarp, on germination extent is shown in Table 2.

Table 2. Percent germination comparison (in 48 hours) of two sources of kochia seed, four seed sizes, with or without pericarp.

Seed size based on mesh size	Texas (Nieto)		Saskatchewan (Marin)	
	Pericarp coated	Uncoated	Pericarp coated	Uncoated
>16	93	100*	69	97
>18	90	97	77	91
>20	81	93	60	77
>30	56	69	24	34

*Germination complete in 8 hours.

Some seeds began germinating within the first few hours of incubation, but did not grow further in the 48 hour time of the trial. (Adding 1 ml of water after 24 hours may eliminated some of this problem since the filter paper seemed to be drier after this time.)

The conclusions from these initial experiments were as follows:

1. Large seed germinated faster and more completely than small seed.

2. Seed with pericarp attached germinated more slowly, and less completely (in 48 hours), than seed with pericarp removed. This implied a physical and/or chemical effect of pericarp on seed germination rate and extent in 48 hours.

3. Texas seed germinated more rapidly than Saskatchewan kochia.

4. All three factors interacted positively, i.e. selecting for Texas seed, for largest seed size, and for removal of pericarp, would lead to the fastest and most complete germination.

However, the largest sized Saskatchewan seed, with pericarp removed, gave 97% germination in 24 hours (Table 2) which should be considered very acceptable.

We have assumed a target population of 100 kochia plants per m^2 for forage production. With a target yield of 2000 kg/ha of kochia seed, with calyx and pericarp removed (Coxworth, Bell and Ashford, 1969), there would be produced 114 kg/ha of large seed (5.7% of 2000 kg/ha). Assuming 100% germination of large seed (see Table 1), we would need 1.008 kg of large seed to sow one hectare:

i.e. $10{,}000\ m^2/ha \times 100\ seeds/m^2 \times \frac{1.008\ g}{1000\ seeds} \times \frac{1\ kg}{1000\ g} = 1.008\ kg/ha$

Thus the harvest of seed of all sizes from one hectare of land would yield enough large seed to seed 113 hectares (114 kg large seed at 1.008 kg/ha).

Further measurement of seed size distribution and seed yields would be required to confirm these initial estimates.

Trials to measure plant growth for the initial 4 weeks after germination of selected seed would be helpful.

These further trials should also examine emergence, growth and final yield of kochia forage, from seed of different selected sizes, to

determine if there are advantages to selecting for large seed size. Questions which need to be addressed include:

1. Can larger seed be sown deeper in the field and still get good emergence of plants?

2. Does forage yield and quality vary with seed size and/or seeding depth?

3. Does selecting for large size lead to progressive increases, over the years, in percent of harvested large seed, and in the seed weight of the largest seed?

Effect of seed size on germination and early growth of Saskatchewan kochia

There was no significant differences (at the 5% level) in seed germination (as measured by seedling emergence) by either seed size or seeding depth. Seedling emergence averaged 75% for the small seed and 78% for the large seed.

Seedling fresh weight after 21 days was significantly affected by seed size and seeding depth (Table 3).

Table 3. Effects of seed size and planting depth on fresh weight of kochia seedlings after 21 days.

Seeding Depth (mm)	Seed Size	Fresh Weight (g)
6	Small	2.15[b]
10	Small	2.18[b]
15	Small	1.58[a]
6	Large	2.64[b]
10	Large	3.21[c]
15	Large	2.53[b]

Means within a column with the same superscript are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Seedling fresh weight when planted at 3 mm depth was also determined. For small seed size, fresh plants weighed 2.05 g, not significantly different from small seeded kochia planted 6 mm deep. The large seed size test at 3 mm planting was accidentally watered differently at the beginning of the experiment and much of the seed was washed away and did not germinate properly, so this result was not included in the statistical analysis.

Seedling height at 14 days and 21 days was also determined (Table 4).

Table 4. Effects of seed size and seeding depth on seedling height at 14 and 21 days.

Seeding Depth	14 Days Growth		21 Days Growth	
(mm)	Small Seed	Large Seed	Small Seed	Large Seed
3	16	n.d.	34	n.d.
6	14	16	26	34
10	13	17	32	39
15	10	15	27	36
Significance of seed size	**		N.S.	
Significance of seeding depth	N.S.		N.S.	

The 3 mm planting depth trial was repeated using watering methods which did not wash away seed. After 18 days growth the large seed plants were significantly taller (30 mm) than the small seed plants (20 mm).

In a recent review, Niemegeer (1988) noted that Everitt et al. (1983) had found that emergence of kochia was 74% when sown on the soil surface, reduced to 57% when kochia was seeded to a 3 mm depth. In the

present study kochia emergence was not affected by seeding depths from 3 to 15 mm, under growth room conditions. Zorner, Zimdahl and Schweiger (1984) determined that 5 cm was the greatest depth from which kochia could successfully emerge, but that emergence decreased with depth. In our study the fresh weight of young plants was reduced at the greatest depth tested (15 mm). However, seedling weight was also lower at very shallow planting depths, implying that there was an optimum planting depth, also dependent on seed size.

The large seed size gave rise to the largest plants after 21 days growth, when planted at the optimum depth.

CONCLUSIONS

These initial experiments indicate that seeding depth and seed size have an effect on early growth of kochia seedling. Removal of calyx and pericarp improve rate and extent of germination. Texas kochia seed germinated faster and more completely than Saskatchewan kochia but large seed of either source type gave very satisfactory germination when the calyx and pericarp were removed.

All these factors need to be tested in field trials. Field trials need to be carried through to forage harvest, to determine if these factors, particularly seed size, have an influence on final forage yield.

REFERENCES

Everitt, J.H., Alaniz, M.A. and Lee, J.B. 1983. Seed germination characteristics of Kochia scoparia.

Niemegeers, M.A. 1988. Kochia: a potential agricultural crop. Term paper (class 492.3) submitted to the Dept. of Crop Science and Plant Ecology, University of Saskatchewan, Saskatoon, Saskatchewan.

Tibelius, A.C. and Klinck, H.R. 1986. Development and yield of oat plants grown from primary and secondary seeds. Can. J. Plant Sci. 66:299-306.

Zorner, P.S., Zundahl, R.L. and Schweizer, E.E. 1984. Effect of depth and duration of seed burial on kochia. Weed Sci. 32:602-607.